STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME
MARINE RESOURCES REGION

A SURVEY OF THE MARINE ENVIRONMENT NEAR THE CITY OF CARMEL OCEAN OUTFALL

by

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STATE WATER RESOURCES CONTROL BOARD
CONTRACT (F&G S-904)

MARINE RESOURCES REGION
Administrative Report 72-9

November 1972

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INTRODUCTION

The California Department of Fish and Game and the State Water Resources Control Board (through Regional Board #3, Central Coast) entered into an agreement whereby Department biologist-divers conducted a subtidal ecological investigation of the marine environment in the vicinity of the city of Carmel ocean outfall in Carmel Bay. The objective of the study was to provide the Regional Water Quality Control Board (RWQCB) with data to assist them in evaluating the effects of the discharge on the marine environment at five stations selected by the RWQCB adjacent to the outfall terminus and two at a control area off Granite Point (Figure 1), and to provide pre-discharge data for a new discharge being constructed adjacent to the existing one.

The determinations made by biologist-divers included: (i) the number and diversity of plant and animal life; (ii) substrate characteristics; and (iii) physical parameters, including water temperature and clarity.

The State Water Resources Control Board reimbursed the Department for some expenses incurred during this study. The work was performed by California Department of Fish and Game biologists from the Department's research vessel KELP BASS.

AREA DESCRIPTION

The city of Carmel ocean outfall is located in Carmel Bay approximately 300 yards south of the mouth of the Carmel River at a depth of

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1/ Prepared at California State Fisheries Laboratory, Marine Resources Region, 350 Golden Shore, Long Beach, California 90802.

4 feet below MLLW. The discharge enters the bay at the southern end of a 600 yard long steep sand beach. The beach is directly exposed to the prevailing sea and is bordered by a rock headland on the north and a small rock reef on the south.

METHODS

The general methods used in this survey are described in reports of previous investigations (Turner, Ebert and Given, 1968). Field operations were conducted by Department biologists on September 21 and 22, 1971, from the Department's 92-foot research vessel, KELP BASS. Due to the shallow station depths and heavy swells, we were unable to place the KELP BASS on the stations, therefore all operations were conducted from a 17-foot skiff.

The station plan selected by the RWQCB called for stations to be located along four transects. Transect C-1 was to be along the present outfall; C-2 parallel to and 500 feet north of the present outfall; C-3 parallel to and 500 feet south of the present outfall; and C-4, 315°T off Granite Pt. in Pt. Lobos State Reserve (Figure 1). Stations were located at 20 and 40 feet depths at each transect except at transect C-1, where only the 40 foot station was occupied because of the proximity of the outfall.

A pier constructed within 20 feet of the old discharge was the reference point used in locating Transects C-1, C-2, and C-3, and visual sightings off Granite Point were used in locating Transect C-4.

Rock and rock-sand stations (C-1, C-3A, C-3B, C-4A, C-4B) were defined by attaching a 2.2 m line to the station marker, and inscribing an arc encompassing approximately 15 m^2, while pure sand bottom sites (C-2A, C-2B) were marked with a 3.1 m line inscribing an arc of 30 m^2. Biologist-divers identified and enumerated all macroscopic plants and animals within the arcs and collected all forms within a 1/16m^2 quadrat

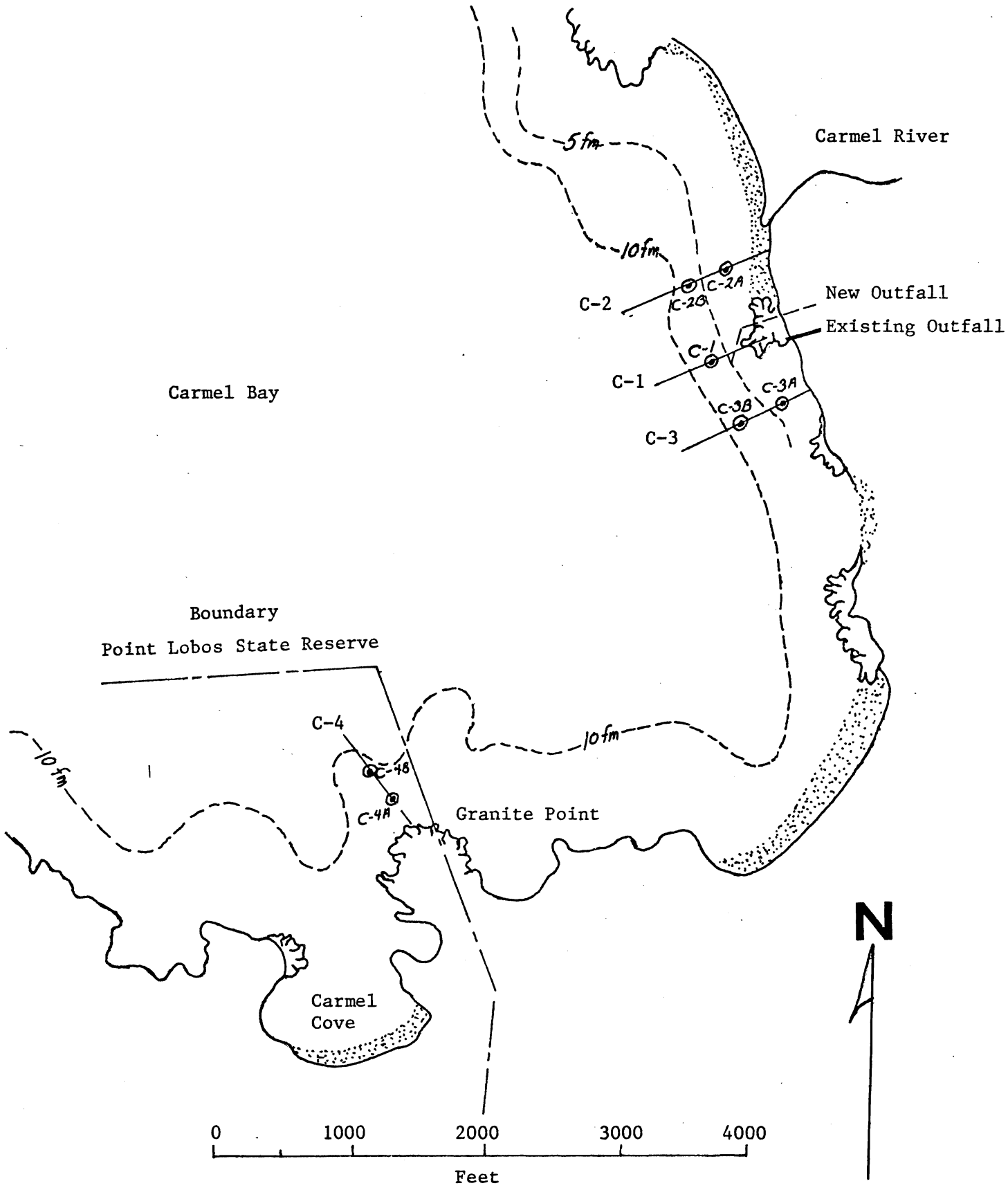

FIGURE 1. City of Carmel Ocean Outfall Sampling Stations

randomly placed within the arc at Stations C-2A, C-2B, C-3B and C-4A. Water temperatures and visibility estimates were taken at 10-foot intervals from the surface to the bottom at each station. General bottom conditions noted included substrate description; height, period and direction of ripple marks; and the presence of suspended organic material (leptopel) in the water column and on the bottom.

Benthic grab samples were not taken as we were unable to operate the grab from the skiff.

RESULTS - PHYSICAL

Three general habitats were encountered during this investigation (Table 1). Stations C-2A and C-2B consisted of fine white shifting sand similar to the white silica sand beaches found in the vicinity. Station C-1, directly offshore from the discharge, consisted of fine gray sand with a rock outcrop and Station C-3B was of fine gray sand with three large rocks. Stations C-3A, C-4A and C-4B were entirely on granite rock.

Visibility on the bottom was generally good and ranged from 10 feet at Station C-2B to 40 feet at Stations C-1 and C-4B (Table 2). It is interesting to note that visibility directly offshore from the discharge was greater than at stations 500 feet to either side, suggesting the discharge field disperses laterally more than offshore. Bottom temperatures ranged from 54 to 56°F (Table 2). No thermocline was present at the stations surveyed, however, temperature dropped as much as 4°F within 40 feet at Station C-3B. Leptopel was not noted in the water column at any station and flocculent organic material was present on the bottom only at Station C-3B.

TABLE 1. City of Carmel Ocean Outfall Station Data.

Station	Date	Depth (Ft.)	Bottom Temp. (F)	Bottom Visibility (Ft.)	Bottom Description
C-1	9-22-71	40	55°	40	Fine gray sand with 6' high granite rock outcrop. Quadrat not taken.
C-2A	9-21-71	22	54.5°	20	Fine white shifting sand. Ripples NNE-SSW, 2'-3' period, 8"-12" high. Quadrat taken.
C-2B	9-21-71	45	54°	10	Fine white loosely packed sand with light flocculent material on ripple crests and small pieces of drift algae. Ripples NNW-SSW, 4"-6" period, 1/2" high. Quadrat taken.
C-3A	9-21-71	20	56°	20	Irregular granitic rock with 4' relief. Quadrat not taken.
C-3B	9-21-71	40	54°	30	Fine gray sand with occasional rocks. 70% of arc within dense colony of polychaete worms forming a 2'-3' high relief. Quadrat taken.
C-4A	9-22-71	20	56°	20	Granitic rock shelf adjacent to exposed wash rock. Quadrat taken.
C-4B	9-22-71	40	55°	40	Top of granite ridge, 5' relief. Quadrat not taken.

TABLE 2. City of Carmel Ocean Outfall Vertical Temperature and Visibility Profiles

C-1

Depth (Ft.)	Temp. (°F)	Vis. (Ft.)
SS	57°	20
10	56°	30
20	56°	30
30	55°	40
40	55°	40

C-2A

Depth (Ft.)	Temp. (°F)	Vis. (Ft.)
SS	56°	15
10	56°	15
20	55°	20
22	54.5	20

C-2B

Depth (Ft.)	Temp. (°F)	Vis. (Ft.)
SS	57°	5
10	56°	8
20	54°	20
30	54°	20
40	54°	20
45	54°	10

C-3A

Depth (Ft.)	Temp. (°F)	Vis. (Ft.)
SS	58°	20
10	57°	20
20	56°	20

C-3B

Depth (Ft.)	Temp. (°F)	Vis. (Ft.)
SS	58°	20
10	57°	20
20	56°	20
30	55°	30
40	54°	30

C-4A

Depth (Ft.)	Temp. (°F)	Vis. (Ft.)
SS	59°	15
10	56°	15
20	56°	20

C-4B

Depth (Ft.)	Temp. (°F)	Vis. (Ft.)
SS	57°	30
10	56°	30
20	56°	30
30	55°	30
40	55°	40
50	54°	40

RESULTS - BIOLOGICAL

Macroscopically, the biota appeared normal at all stations (Table 3). Biotic assemblages were dependent on habitat types and the most diverse and luxuriant were found on rock bottom. The biota associated with the shifting sand bottoms was comparatively depauparate in both biomass and diversity.

Sampling at Station C-1, directly offshore from the discharge at a depth of 40 feet, revealed 41 taxa of invertebrates, 11 algae and 3 genera of fish. Except for the sanddabs (*Citharichthys* sp.) all plants and animals were recorded on the rocky portion of the arc and none in the sand. Had the arc not included the rocky outcrop, the station would have shown a very sparse biota.

Stations C-2A and C-2B were similar, the only macroscopic organisms observed were two species of olive snails (*Olivella biplicata* and *O. pycnia*), hermit crabs (*Pagurus* sp.), and sanddabs (*Citharichthys* sp.) In addition to the above, the polychaete worm *Diopatra* sp., was recorded at Station C-2B.

Generally the animals at these stations were in low concentrations with the exception of *Olivella biplicata* which were found to be abundant at Station C-2A. Such a paucity of animals is typical for areas of shifting sand bottoms.

On Station C-3A, 37 taxa of invertebrates, 9 fish species, and 6 algae were recorded, all typical of a rocky habitat. Station C-3B, however, was predominatly sand and contained fewer macroscopic plants and animals. The dominant feature of the sand portion was a dense population of tube building polychaetes including *Chione* sp. *Dioptra ornata, Phragmatopoma californica,* and *Sabellaria cementarium,* forming a dense mat approximately 2-3 feet higher than the surrounding sea floor.

TABLE 3. Plants and Animals Recorded from the Vicinity of Carmel Ocean Outfall, September 21 and 22, 1971

Scientific name	Station and Abundance*						
	1	2A	2B	3A	3B	4A	4B
ALGAE							
Acrosorium uncinatum	P						P
Bossiella gardneri	P			P		P	P
B. interrupta						[P]	
B. orbigniana	P			P		[P]	
Bossiella sp.	A					A	
Botryoglossum sp.						A	P
Corallina officinalis chilensis	P					[P]	
Corallina sp.				P	P		
Coralline, unid.	P						
Cystoseira osmundacea						S	
Dictyoneurum californicum						S	
Eisenia arborea						1	
Gigartina californica	P						
G. corymbifera	P			P			
G. cristata						[P]	P
G. papillata						[P]	P
Gigartina sp.				P		C	
Halosaccion glandiforme						P	
Hymenena sp.						[P]	
Iridaea sp.						C	
Laminaria andersonii						P	P
Lithothamnion sp.	P						
Lithothrix aspergillum						[P]	
Macrocystis pyrifera	S			C	P	C	A (juv.)

TABLE 3 - Continued

Scientific name	Station and Abundance*						
	1	2A	2B	3A	3B	4A	4B
Peyssonelia sp.						P	
Pterygophora californica						P	
Rhodoglossum affine						P	
Rhodymenia pacifica	A					P	
Rhodymenia sp.							P
PORIFERA							
Halichondria panicea							P
Polymastia pachymastia	P						
Sponge, encrusting unid.	P			P		P	A
Sponge, encrusting yellow unid.	P						
CNIDERIA							
Aglaophenia sp.					P	P	
Allopora californica						P	
Anthopleura xanthogrammica				S	1	36	
Anthozoan, unid.					P		P
Balanophyllia elegans				A		S	
Corynactis californicus	S			P		A	A
Epiactis prolifera						S	
Hydrozoan, unid.				P			
Plumularia sp.	P						
Tealia loforensis	P			3		P	
NEMATODA							
Nematode, unid.						[4]	
NEMERTEA							
Nemertean, unid.						[2]	P

TABLE 3 - Continued

Scientific name	Station and Abundance *						
	1	2A	2B	3A	3B	4A	4B
ANNELIDA							
Arabella iricolor						[1]	
Branchiomaldane vincentii						[1]	
Capetellidae					P		
Chaetopteridae						[1]	
Chone (cf.) *infundibuliformis*					[10-25]		
C. minuta						[5]	
Dioptra ornata					[50-75]		
Diopatra sp.			2	P			
Dodecaceria fewkesi						C	C
Eudislylia polymorpha	P			C		P	C
Halosydna brevisetosa						[4]	P
Maldanidae					P		
Nereidae						[P]	P
Nereis sp.						[5]	
Orbiniidae						[1]	
Phragmatopoma californica				[12]			
Phyllodocidae	P				P		P
Polydora sp.	P					[2]	
Polynoidae	P						P
Sabellaria cementarium	P				[12]	[1]	
Sabellaria sp.	P						
Sabellidae						[1]	C
Serpulidae	P			P		C	

TABLE 3 - Continued

Scientific name	Station and Abundance*						
	1	2A	2B	3A	3B	4A	4B
Syllidae					P	P	P
Terebellidae, unid.						P	
Typosyllis sp.						[21]	
SIPUNCULIDA							
Sipunculid, unid.	P			P	P	[2]	
MOLLUSCA							
Acmaea instabilis						P	
A. mitra						P	
A. triangularis						[20]	
Acmaeidae, unid.				P		P	
Anisodoris nobilis	P					1	P
Astraea gibberosa					P		
Balcis sp.						[2]	
Barleeia sp.						[3]	
Calliostoma annulatum							P
C. caniculatum	P						
C. ligatum	P			P		[3]	
C. tricolor							P
Crepidula adunca					P		P
Crepidula sp. (spat)						[1]	
Cryptochiton stelleri	C			1		7[2]	1
Dendrodoris fulva					1		
Diaulula sandiegensis						1	
Gastropoda, unid.					[25]	A	P
Haliotis walallensis				S			
Hiatella arctica	P					[1]	

TABLE 3 - Continued

Scientific name	Station and Abundance*						
	1	2A	2B	3A	3B	4A	4B
Megathura crenulata				1	1	2	
Mitrella carinata					P		
M. tuberosa					P		
Nudibranchia, unid.	P						3
Ocenebra faveolata							P
Olivella biplicata		A[1]	S				
O. pycnia			S				
Pododesmus cepio					P		P
Tegula brunnea	P					P	
T. montereyi						P	
Tonicella lineata				P			
Tricolia sp.						[5]	
ATHROPODA							
Balanus crenatus	P						
B. flos						P	
B. nubilus							P
Balanus sp.				A	P		
B. tintinnabulum californicus	P						
Cancer productus (juv.)					1		
Caprellidea						[7]	
Cryptolithodes sitchensis					1		
Gammaridea				P	P	[45]	P
Idotea sp.						[1]	
Isopoda, unid.				P			
Loxorhynchus crispatus				P			P

TABLE 3 - Continued

Scientific name	Station and Abundance*						
	1	2A	2B	3A	3B	4A	4B
L. grandis (juv.)							1
Loxorhynchus sp. (juv.)				P			P
Metacaprella sp.						P	
Mimulus foliatus				P			P
Pagurus sp.	P	P	5			P	P
Phyllolithodes papillosus							P
Pugettia gracilis						P	
P. productus	P						
P. richii	P			P			P
Pugettia sp.							P
Pycnogonum rickettsi					P		
Scyra acutifrons	P			P			P
Synidotea consolidata						P	
Tanaidacea, unid.						[1]	
ECTOPROCTA							
Bryozoan, unid.							P
Crisia sp.	P					P	
Diaperoecia californicus						P	
Entalophoridae				P			
Heteropora sp.	P			A			P
Hippodiplosia insculpta						P	P
Phidolopora pacifica	P					P	
ECHINODERMATA							
Cucumaria (cf.) *piperata*	P				P		
Dermasterias imbricata	P			1			4
Henricia leviuscula						4	

TABLE 3 - Continued

Scientific name	Station and Abundance*						
	1	2A	2B	3A	3B	4A	4B
Henricia sp.	1						C
Holothuroidea, unid.						[3]	
Linckia sp.				1			
Lytechinus anemesus				5			
Ophiopholis aculeata						P	
Ophioplocus esmarki					P		
Ophiothrix spiculata							P
Ophiuroidea, unid.	P			P			P
Patiria miniata				27	4	C[1]	S
Pisaster brevispinus				3		2	11
P. giganteus	P			1		1	S
Pycnopodia helianthoides	5			1			
Solaster dawsoni	1						
Strongylocentrotus purpuratus						18	
Strongylocentrotus sp. (juv.)	S			S			
ASCIDIACEA							
Ascidian, unid.	P					[P]	
Ascidian, colonial unid.				C		P	P
Cystodytes sp.	P						
Styela montereyensis	C			C	2	S	1
PISCES							
Artedius sp.				(P)		P	
Bothrogonus swanii	P						
Citharichthys sp.	A		[1]A				
Citharichthys stigmaeus		3			A		
Cottidae, unid.					C		P

TABLE 3 - Continued

Scientific name	Station and Abundance *						
	1	2A	2B	3A	3B	4A	4B
Embiotoca lateralis						(P)	
Gibbonsia sp.				(P)			P
Hexagrammos sp.				(P)			(P)
Orthonopias triacis							(P)
Oxylebius pictus	(P)			(P)2		(P)	P
Rhacochilus vacca				(P)			
Sebastes atrovirens				(P)		(P)	(P)
S. chrysomelas						(P)	
S. mystinus				(P)		(A)	P
S. serranoides						(P)	(P)
Sebastes sp. (juv.)				(P)			
Scorpaenichthys marmoratus				(P)			

* Abundance symbols

A = Abundant, numerous and evenly distributed throughout the arc

C = Common, unevenly present throughout the arc and only occasionally numerous

S = Sparse, widely scattered throughout the arc but nowhere numerous

P = Present in the area but relative abundance not estimated

[] = Occurrence within quadrat 0.25 m on a side

() = Extralimital observation

The arc also contained 3 large rocks heavily overgrown with adult *Macrocystis* plants. A total of 33 taxa were recorded for this station including 29 invertebrates, 2 fish and 2 algae.

Control Stations C-4A and C-4B were both on rock bottoms within the boundaries of Pt. Lobos State Reserve and the greatest total numbers of plants and animals were recorded from these stations. Station C-4A revealed 68 taxa of invertebrates, 21 algae and 7 species of fish while 45 taxa of invertebrates, 8 fish species and 8 algae were recorded from C-4B.

The high counts in Station C-4A occur in three groups; algae, polychaetes and molluscs, all of which were abundant in the 1/16 m^2 quadrat taken at C-4A.

Nearly all of the animals and many of the algae recorded from the quadrat only are not seen while diving and these would not be recorded unless samples were taken. By deleting the plants and animals found exclusively in the quadrat from the arc total, the count for Station C-4A is 40 invertebrate taxa, 14 algae, and 7 fish, which is more comparable to the other rock stations.

CONCLUSIONS

The nearshore rocky bottom habitat in the Carmel region is exceptionally diverse in marine organisms and the biological assemblages are very complex. A survey of this type with no pre-discharge data is not adequate to describe changes in the biota that may be attributable to discharges unless the environmental changes are gross.

The impressions of the biologist-divers are that the biota observed in the region of the outfall is comparable to that found elsewhere in Carmel Bay in similar habitat types. However, this does not necessarily give the discharge a "clean bill of health" for the study

was; (1) cursory in nature, and (2) did not attempt to measure the accumulation of toxic substances in the environment or in the animals.

It must also be mentioned at this point that this study is not considered by us to be an adequate pre-discharge study for monitoring the new discharge. An adequate pre-discharge study must include additional stations within the discharge field and at representative habitat types outside the discharge field.

ACKNOWLEDGMENTS

Robert Hardy and Dan Odenweller conducted the survey with the assistance of Mitchell Gillis and the captain and crew of the R/V KELP BASS. Thanks are due to Brad Myers, Richard Dixon and Cynthia Klepadlo for sorting the specimens, to Robert Hardy for polychaete identification, and to Charel Cueva for typing the manuscript.

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